Non-linear Regge spectrum fits to experimentally up-dated meson states

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The exciting feature of recent times is the inflow of new experimental data. Fits to the π, ρ and f meson resonances found by the VES collaboration, along with those of the PDG 1998 compilation are reported using a non-linear model for Regge trajectories. There are only five parameters including the pion mass and the states come out as Regge -type excitations of the pion. Total number of mesons fitted are 23 and the fit is good to $\sim 3\%$ for 18 of them and $\sim 9\%$ for others.

We have suggested the use of a modified Regge trajectory for heavy as well as light mesons and in the case of the upsilon radial excitations the non-linearity is most prominent [1]. The trajectories are based on the use of deformed Poincaré algebra for the internal degrees of freedom of the hadron. In fact it was shown recently [2] that the kinetic excitation of the hadron must obey the usual Einstein relation in order that the thermodynamic functions can be defined for the system, and that the limiting temperature predicted by the fit is larger than the older Hagedorn estimate.

The square of masses of the resonances is given in the model by

$$E^2 = Sinh^{-1}[sinh^2(\frac{m\epsilon}{2}) + (\frac{\epsilon^2}{4})(\frac{L}{\alpha'} + \frac{L}{\beta'} + \frac{S}{\gamma'} + \frac{J}{\delta'})] \tag{1}$$

The parameters we choose are $\alpha' = 0.72$, $\beta' = 0.62$, $\gamma' = 2.1$ and $\delta' = 9.2$, all in GeV^{-2}. The parameter ϵ is taken to be 0.912 GeV^{-1} as found in [1] from the upsilon fit. The states are given in the following tables.

Table 1 gives the pion states. Note the state $\pi(1740)$ given by [3], revised from the PDG value 1800 fits exceedingly well with our model. These states, revised by [3] and [4] was the motivation for this addendum and are shown by us with a superscript asterisk, in the Tables.

We have not tried to fit the ρ and a separately from the ω and the f mesons, since they are roughly degenerate. This could be done easily by choosing the α' , β' , γ' and δ' separately for the two sets but is not otherwise very meaningful. There are very few omega meson states (4) and the f mesons are excitations of both ω and η. The new experiments do not report η mesons and they are not considered in this paper. But all the mesons as well as baryons can be fitted in the model [2]. The interesting point is the inflow of the more recent data.

The Table 2 shows the fits to the $\rho - \omega$ system. Note that the new $a_1(1800)$ state reported by [3] with an experimental error of 50 MeV and width 230 MeV, fits very well into our scheme as a nodal excitation, n =1, in the L = 1 channel.

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[1] J. Dey, M. Dey, P. Leal Ferreira and L. Tomio, Phys. Lett. B 365(1996) 157 ; Addendum 369 (96) 377.
[2] J. Dey, S. Bhowmik, K. Ray and S. Ray, Indian J. Phys. 73 B (1999) 409.
[3] V. Dorofeev, hep-ex/9905002
[4] V. Dorofeev and D. Bugg, hep-ex/9905001

TABLE I. The π meson states in MeV.

Experiment	Our fit	Comment	Experiment	Our fit	Comment
$\pi(139)$	139	fitted	$b(1235)$	1200	error 3%
$\pi(1300)$	1266	error 3%	$\pi(1740)^*$	1743	error 0.2%
$\pi 2(1670)$	1658	error 0.8%	$\pi(2100)$	2067	error 2%

TABLE II. The ρ, a and ω, f mesons in MeV.

Experiment	Our fit	Comment	Experiment	Our fit	Comment
$\rho(770)$	776	1%	$\omega(782)$	776	error 1%
$a_1(1260)$	1374	error 9%	$f_1(1285)$	1374	error 9%
$a_2(1360)$	1428	error 5%	$f_2(1270)$	1410	error 10%
$\rho_3(1690)$	1799	error 8%	$\omega_3(1670)$	1799	error 9%
$\rho_3(2180)^*$	2108	error 4%	$\rho(1450)$	1465	error 1%
$\rho_3(2300)$	2330	error 2%	$a_1(1800)^*$	1813	error 0.5%
$a_4(2040)$	2079	error 2%	$f_4(2050)$	2080	error 1.5%
$a_6(2450)$	2464	error 0.5%	$f_6(2510)$	2464	error 2%
$\rho_5(2350)$	2293	error 3%	$\rho_3(2250)$	2264	error 0.5%